MULTIMEDIA UNIVERSITY

STUDENT ID NO

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# MULTIMEDIA UNIVERSITY

# FINAL EXAMINATION

**TRIMESTER 1, 2017/2018**

## DTC5088 – ANALOG AND DIGITAL COMMUNICATION SYSTEMS

(Diploma in Electronics Engineering)

16 OCTOBER 2017
2.30 PM – 4.30 PM
(2 Hours)

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**INSTRUCTIONS TO STUDENT**

1. This question paper consists of **6** pages (**3** pages with **5** questions and **3** pages for appendix).

2. Attempt **ALL** questions. All necessary work step must be shown.

3. Write all your answers in the answer booklet provided.

## QUESTION 1 [20 marks]

(a) Distinguish between the analog communication source and digital communication source and provide one example for each source. (4 marks)

(b) Discuss the advantages and disadvantages of the analog communication systems and digital communication systems. (8 marks)

(c) Figure 1 shows the time signal $x(t)$. Perform the following signal operations:

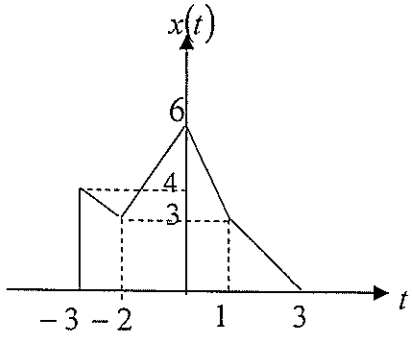


Figure 1

(i) $x\left(\frac{4t-1}{3}\right)$ (4 marks)

(ii) $x(8-t)$ (4 marks)

**Continued ...**

**QUESTION 2 [20 marks]**

(a) Explain the process of the modulation and demodulation in the communication systems with aid of appropriate diagram. (4 marks)

(b) A modulating signal, $s_m(t) = 10\cos(20000\pi t)$ is modulated to a carrier signal, $s_c(t) = 8\cos(300000\pi t)$ to produce double sideband with suppressed carrier (DSB-SC) signal:

(i) Express the amplitude-modulation equation for DSB-SC (6 marks)

(ii) Construct a frequency spectrum for the modulated signal by assuming the signal is a multi-tone signal. (4 marks)

(iii) Calculate the modulation index and percentage of modulation. (2 marks)

(iv) Identify the type of the modulation in (iii) and describe its behavior with aid of appropriate diagram. (4 marks)

**QUESTION 3 [20 marks]**

(a) Explain the importance of the sensitivity parameter in the superheterodyne receiver and how to improve it. (4 marks)

(b) Sketch a block diagram of FM superheterodyne receiver and label each section clearly. (8 marks)

(c) Briefly describe the function of pre-emphasis and de-emphasis network during the transmission. (6 marks)

(d) Explain the function of the detector section in the superheterodyne receiver. (2 marks)

**Continued ...**

**QUESTION 4 [20 marks]**

(a) Briefly explain TWO types of the Pulse Modulation Systems. (4 marks)

(b) Define sampling rate. (2 marks)

(c) An input signal with the highest frequency of 40 kHz is to be received in a digital device by using Pulse Code Modulation (PCM) technique. The input signal is sampled at Nyquist rate and a sample encoded with 16 bits only. Determine:

(i) Sampling rate (2 marks)

(ii) Quantization level. (2 marks)

(iii) Bite rate of the PCM signals. (2 marks)

(d) Given a bandwidth of a transmission medium used is 25,000 Hz (5,000 to 30,000 Hz). If the transmission is in ASK full-duplex mode, find the carrier frequencies and its bit rate in each direction. (Assume there is no gap between the bands in the two directions) (5 marks)

(e) Describe the advantages of QAM compared to the ASK and FSK. (3 marks)

**QUESTION 5 [20 marks]**

(a) Briefly describe THREE types of the Digital to Digital Encoding. (6 marks)

(b) Encode the data stream 10100001001 using the following encoding schemes:

(i) Bipolar RZ. (2 marks)
(ii) Differential Manchester. (2 marks)
(iii) AMI. (2 marks)
(iv) HDB3 (2 marks)

(c) Describe single bit error and suggest one error detection mechanism to solve this problem. (2 marks)

(d) Construct the Hamming Code before the transmitter transmit the bit sequence of 100110110 to the receiver. (4 marks)

**End of Page.**

# APPENDIX

## (A) Amplitude Modulation

Carrier signal, $s_c(t) = A_c \cos(\omega_c t)$

Modulating signal, $s_m(t) = A_m \cos(\omega_m t)$

Amplitude-modulated signal,

DSB-LC: $s(t) = A_c \cos\omega_c t + \frac{A_m}{2}\cos(\omega_c - \omega_m)t + \frac{A_m}{2}\cos(\omega_c + \omega_m)t$

DSB-SC: $s(t) = \frac{A_m A_c}{2}\cos(\omega_c + \omega_m)t + \frac{A_m A_c}{2}\cos(\omega_c - \omega_m)t$

SSB-SC:

LSB : $s_{LSB}(t) = \frac{A_m A_c}{2}\cos(\omega_c t - \omega_m t)$

USB : $s_{USB}(t) = \frac{A_m A_c}{2}\cos(\omega_c t + \omega_m t)$

## (B) Frequency Modulation

$$\phi_{FM} = A_c J_0(m_f)\sin\omega_c t +$$
$$A_c\left(J_1(m_f)(\sin(\omega_c + \omega_m)t - \sin(\omega_c - \omega_m)t)\right) +$$
$$A_c\left(J_2(m_f)(\sin(\omega_c + 2\omega_m)t - \sin(\omega_c - 2\omega_m)t)\right) +$$
$$A_c\left(J_3(m_f)(\sin(\omega_c + 3\omega_m)t - \sin(\omega_c - 3\omega_m)t)\right) +$$
$$A_c\left(J_4(m_f)(\sin(\omega_c + 4\omega_m)t - \sin(\omega_c - 4\omega_m)t)\right) +$$
$$A_c\left(J_5(m_f)(\sin(\omega_c + 5\omega_m)t - \sin(\omega_c - 5\omega_m)t)\right) + \ldots +$$
$$A_c\left(J_n(m_f)(\sin(\omega_c + n\omega_m)t - \sin(\omega_c - n\omega_m)t)\right)$$

*Bessel table function*

| Modulation Index ($m_f$) | Carrier Frequency $J_0$ | n or order of sidebands | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $J_1$ | $J_2$ | $J_3$ | $J_4$ | $J_5$ | $J_6$ | $J_7$ | $J_8$ | $J_9$ | $J_{10}$ | $J_{11}$ | $J_{12}$ | $J_{13}$ | $J_{14}$ | $J_{15}$ | $J_{16}$ |
| 0.00 | 1.00 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 0.25 | 0.98 | 0.12 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 0.5 | 0.94 | 0.24 | 0.03 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 1.0 | 0.77 | 0.44 | 0.11 | 0.02 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 1.5 | 0.51 | 0.56 | 0.23 | 0.06 | 0.01 | — | — | — | — | — | — | — | — | — | — | — | — |
| 2.0 | 0.22 | 0.58 | 0.35 | 0.13 | 0.03 | — | — | — | — | — | — | — | — | — | — | — | — |
| 2.5 | −0.05 | 0.50 | 0.45 | 0.22 | 0.07 | 0.02 | — | — | — | — | — | — | — | — | — | — | — |
| 3.0 | −0.26 | 0.34 | 0.49 | 0.31 | 0.13 | 0.04 | 0.01 | — | — | — | — | — | — | — | — | — | — |
| 4.0 | −0.40 | −0.07 | 0.36 | 0.43 | 0.28 | 0.13 | 0.05 | 0.02 | — | — | — | — | — | — | — | — | — |
| 5.0 | −0.18 | −0.33 | 0.05 | 0.36 | 0.39 | 0.26 | 0.13 | 0.05 | 0.02 | — | — | — | — | — | — | — | — |
| 6.0 | 0.15 | −0.28 | −0.24 | 0.11 | 0.36 | 0.36 | 0.25 | 0.13 | 0.06 | 0.02 | — | — | — | — | — | — | — |
| 7.0 | 0.30 | 0.00 | −0.30 | −0.17 | 0.16 | 0.35 | 0.34 | 0.23 | 0.13 | 0.06 | 0.02 | — | — | — | — | — | — |
| 8.0 | 0.17 | 0.23 | −0.11 | −0.29 | −0.10 | 0.19 | 0.34 | 0.32 | 0.22 | 0.13 | 0.06 | 0.03 | — | — | — | — | — |
| 9.0 | −0.09 | 0.24 | 0.14 | −0.18 | −0.27 | −0.06 | 0.20 | 0.33 | 0.30 | 0.21 | 0.12 | 0.06 | 0.03 | 0.01 | — | — | — |
| 10.0 | −0.25 | 0.04 | 0.25 | 0.06 | −0.22 | −0.23 | −0.01 | 0.22 | 0.31 | 0.29 | 0.20 | 0.12 | 0.06 | 0.03 | 0.01 | — | — |
| 12.0 | 0.05 | −0.22 | −0.08 | 0.20 | 0.18 | −0.07 | −0.24 | −0.17 | 0.05 | 0.23 | 0.30 | 0.27 | 0.20 | 0.12 | 0.07 | 0.03 | 0.01 |
| 15.0 | −0.01 | 0.21 | 0.04 | −0.19 | −0.12 | 0.13 | 0.21 | 0.03 | −0.17 | −0.22 | −0.09 | 0.10 | 0.24 | 0.28 | 0.25 | 0.18 | 0.12 |

*Source:* E. Cambi, *Bessel Functions*, Dover Publications, Inc., New York, N.Y., 1948. Courtesy of the publisher.

## (C) AM Superheterodyne Receiver

Local oscillator frequency,

$f_{LO} = f_{RF(C)} + f_{IF(C)}$

$f_{LO} = f_{RF(USF)} + f_{IF(LSF)}$

$f_{LO} = f_{RF(LSF)} + f_{IF(USF)}$